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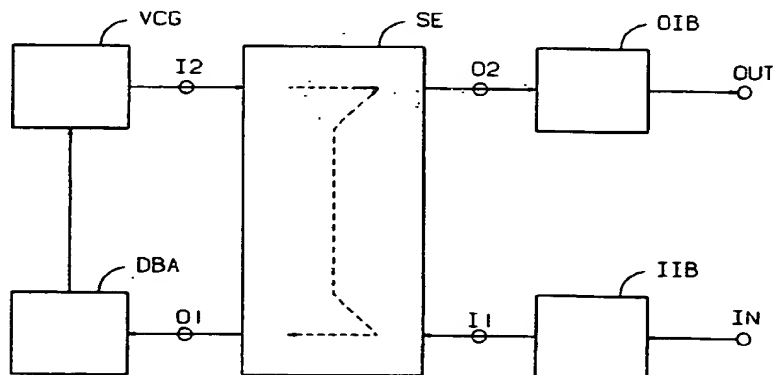
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(54) **Performance measurement device for a telecommunication path and method used therein.**

(57) A device (PMD) and a method for measuring the performances characteristics of a communication path of a telecommunication packet switching network (ATM) by transmitting test packets through this path while other life traffic is operating. The test packets are life data communication packets of the

life traffic and of which the communication data has been replaced by performance measurement data. No traffic of test packets is thereby added to the existing life traffic and the latter is not disturbed by the measurements.

PMD**EP 0 528 075 A1****Best Available Copy**

The present invention relates to a performance measurement device for at least one communication path between a first and a second subscriber location of a telecommunication packet switching network, said device including test packet generation means for generating test packets and for transmitting them through said switching network via said communication path, and packet analyzer means for receiving said test packets from said switching network and for measuring the performance characteristics of said communication path.

For the evaluation of the performance characteristics of a communication path, e.g. the bit error rate, the number of packets lost and/or inserted, the delay jitter, etc..., a "measurement traffic" of test packets has to be generated. This measurement traffic is either constituted by test packets added to the existing life traffic of data communication packets or by test packets simulating such a life traffic.

In case of addition of test packets, the ratio of these test packets on the life packets must remain very low, e.g. less than one percent, to avoid too much disturbance on the performance characteristics of the life transmission. As a result, a long measurement time is required for establishing the packet loss since the latter is generally of about  $10^{-8}$  for a switching network and is calculated by means of the test packets only.

In case of simulation, real time traffic generators or sources are simulated by mathematical models, e.g. by Gaussian or exponential distributions, and to obtain reliable results the simulated test packet stream must resemble as much as possible to the life traffic. This resemblance is however not obvious to obtain in practice.

An object of the present invention is to provide a performance measurement device whereof the test packets do not disturb the other existing real time traffic of the switching network and wherein the generated measurement traffic corresponds exactly to life traffic.

According to the invention, this object is achieved due to the fact that said test packet generation means are adapted to receive life data communication packets from a life traffic source located at said first subscriber location and to transform said life packets into said test packets.

In this way, no test packets are added to the existing real time traffic and the latter is thereby not disturbed. Moreover, because the data communication packets of the life traffic source, e.g. a video source, are used to create the measurement traffic of test packets, this test traffic corresponds exactly to life traffic between the first and second subscriber locations.

It is to be noted that when replacing life packets by test packets, the corresponding life traffic

does no longer exist. A possible solution to keep the life traffic active is to make a copy of the life packets prior to translating them into test packets and to transmit these copies to the second subscriber location via another communication path through the switching network.

Another characteristic feature of the present invention is that said test packet generation means, said packet analyzer means and said life traffic source are all connected to said switching network, and that said life packets are received in said test packet generation means from said life traffic source via said switching network.

The performance measurement device needs thus not to be located exactly at the same location as the life traffic source.

Still another characteristic feature of the present invention is that the performance measurement device further includes packet switching means coupled between said life traffic source and said test packet generation means, said packet switching means being adapted to receive packets and to transmit them either to said test packet generation means or to said switching network according to predetermined parameters stored in said packets.

In this way, all the life packets of a particular type, e.g. video packets, may for instance be transmitted from different life traffic sources to the performance measurement device and more particularly to the packet switching means thereof. On the one hand, the life packets which have to be transformed into test packets are sent by the packet switching means to the test packet generation means whilst, on the other hand, the remaining life packets are sent back to the switching network without modification.

Also another characteristic feature of the present invention is that each of said packets has a data field and a header which stores routing information indicative of the destination of said packet through said switching network and that said predetermined parameters are stored in said header of said packet.

The invention is also characterized by the fact that said packet analyzer means are coupled between said life traffic source and said test packet generation means and are adapted to receive packets, to recognize test packets from life packets and to transmit the latter to said test packet generation means.

Further, said test packet generation means provide one test packet for each of said life packets received from said packet analyzer means and the data field of said test packet stores performance measurement data.

Without modifying the data field of the data communication packets, the only performance

characteristic which can be measured is the packet inter-arrival time because the data communication packets contain no performance measurement data which can be used for determining the other performance characteristics mentioned above.

Furthermore, the header of said test packet provided by said test packet generation means is at least partly identical to the header of the corresponding life packet received from said packet analyzer means.

It is also a feature of the invention that said packet analyzer means are coupled between said packet switching means and said test packet generation means, said packet analyzer means being adapted to receive test packets and to perform the performance measurement in function of performance measurement data stored in the data field of said received test packets.

The performance measurement device is thereby not only able to generate test packets from received data communication packets, but it can also receive test packets and analyze them to obtain the requested performance measurements.

In a preferred embodiment, said switching network is an Asynchronous Transfer Mode (ATM) switching network.

The present invention also relates to a method for measuring the performance characteristics of at least one communication path of a telecommunication packet switching network by transmitting test packets through said network. This method is characterized in that said test packets are life data communication packets of life traffic and of which the communication data is replaced by performance measurement data.

The above mentioned and other objects and features of the invention will become more apparent and the invention itself will be best understood by referring to the following description of an embodiment taken in conjunction with the accompanying drawing which shows a performance measurement device PMD according to the invention.

The performance measurement device PMD forms part of a packet telecommunication system (not shown) which also includes an Asynchronous Transfer Mode (ATM) switching network and life traffic sources and receivers connected thereto. The life traffic sources are located at subscriber locations and generate life data communication packets containing user data such as digital video signals. In normal operation, these life packets are transmitted through the switching network via one or more communication paths from the life traffic source at a first subscriber location to the life traffic receiver at a second subscriber location.

It is to be noted that although in the Asynchronous Transfer Mode (ATM) technique the word "cell" is preferred to the word "packet", only the

latter will be used in the following part of this description.

Each packet has a header and a data field also called payload. The header contains routing information indicative of the destination, i.e. the address of the second subscriber location and parameters allowing at least to identify the type of packet, e.g. a video packet or a maintenance packet. In the Asynchronous Transfer Mode switching technique, the routing information is constituted by a so-called Virtual Channel Identifier/ Virtual Path Identifier (VCI/VPI). The data field contains communication data or user information which, in the case of a video packet, is constituted by digital video signals.

In order to perform measurements on the performance characteristics of a communication path and thus of the telecommunication system and more particularly of the ATM switching network thereof, test packets are generated and are merged with life packets of other communications, e.g. communications between other subscriber locations. These test packets are in fact former life packets of a communication initially intended between the first and the second subscriber locations and of which the user information contained in the data field has been replaced by performance measurement data. Such test packets are generated and analyzed as will be explained later - by the performance measurement device PMD which will be described below.

The performance measurement device PMD shown has an input terminal IN and an output terminal OUT both connected to the ATM switching network. The input terminal IN is connected to a first input I1 of a switching element SE via an input interface board IIB. The switching element SE has a second input I2 and two outputs O1 and O2. The output O1 of SE is coupled to its second input I2 via a distribution based analyzer or packet analyzer circuit DBA and a virtual channel generator or test packet generation circuit VCG in series. Finally, the second output O2 of the switching element SE is connected to the output terminal OUT of PMD via an output interface board OIB.

The interface boards IIB and OIB carry well known standard interface devices and are therefore not described in more detail hereafter.

When for instance the traffic performance has to be measured for life packets, e.g. video packets, transmitted from the first subscriber location, say A (not shown), to the second subscriber location, say B (also not shown), a first performance measurement device PMD, hereafter referred to as PMDA, is installed near to A whilst a second performance measurement device PMD, hereafter referred to as PMDB, is installed near to B. Since both PMDA and PMDB are identical to the above performance measurement device PMD shown, they are not

represented individually.

The switching elements SE of PMDA and PMDB are first initialized to recognize video packets transmitted from the subscriber location A to the subscriber location B. Switching elements such as SE are already known, e.g. from the European patent EP 0.231.967 (P. DEBUYSSCHER 3), and are therefore not described in detail here.

The operation of the ATM switching network is such that all the life packets supplied by the life traffic source at the location A, instead of being transmitted straight away to their destination, i.e. to the life traffic receiver at the location B, are deviated, directly or via the ATM switching network, to the first performance measurement device PMDA. When such a life (video) packet is received at the input terminal IN of PMDA, it is transmitted to the switching element SE via the input interface board IIB. SE then performs a first route selection in function of the routing information stored in the header of the received life packet and which indicates whether this packet is intended to the location B or not. As a consequence, SE transfers the packet either to its output 01 or to its output 02. In more detail, if the life packet belongs to the communication to be measured, i.e. the communication of video packets between A and B, and has thus to be translated into a test packet, SE transfers this life packet to the distribution based analyzer DBA via the output 01. On the contrary, if the life packet belongs to another communication, although also established by A, and must not be used for the test, SE transfers it to the output 02 and from there back to the ATM switching network via the output interface board and the output terminal OUT of PMD. This life packet is then further transmitted to its destination receiver and its transfer through the performance measurement device PMDA remains transparent for the users.

Since the distribution based analyzer DBA receives from the switching element SE selected life packets and, consequently, idle packets in between, the aim of DBA is to recognize idle packets from not-idle or life packets and to send, for each life packet received from SE, a request signal to the virtual channel generator VCG. Additionally, the distribution based analyzer DBA also provides the header of the received life packet to the virtual channel generator VCG. The latter then creates a test packet. The header of this test packet is similar to the header of the corresponding life packet, i.e. contains at least an indication of the address of the destination subscriber location B, but also contains a parameter which indicates that it is a test packet and no more a life (video) packet. Moreover, the data field or payload of the test packet is now loaded with performance measurement data which replaces the former life communication data.

The test packet created by VCG is then transmitted to the switching element SE via the input I2 thereof. SE transfers the test packet from its input I2 to its output 02 and so further to the ATM switching network via the output interface board OIB and the output terminal OUT.

It is to be noted that the virtual channel generator VCG instead of generating a test packet for each life packet received from DBA as described above may also generate real time test packets either automatically, e.g. periodically with a predetermined time interval, or manually upon request of an operator. These possibilities are however not discussed in detail in the present description because the test packets which are then generated by VCG create a measurement traffic which is added to the real time traffic and that the purpose of the invention is to create a measurement traffic which operates in the place of life traffic, i.e. without adding any other traffic.

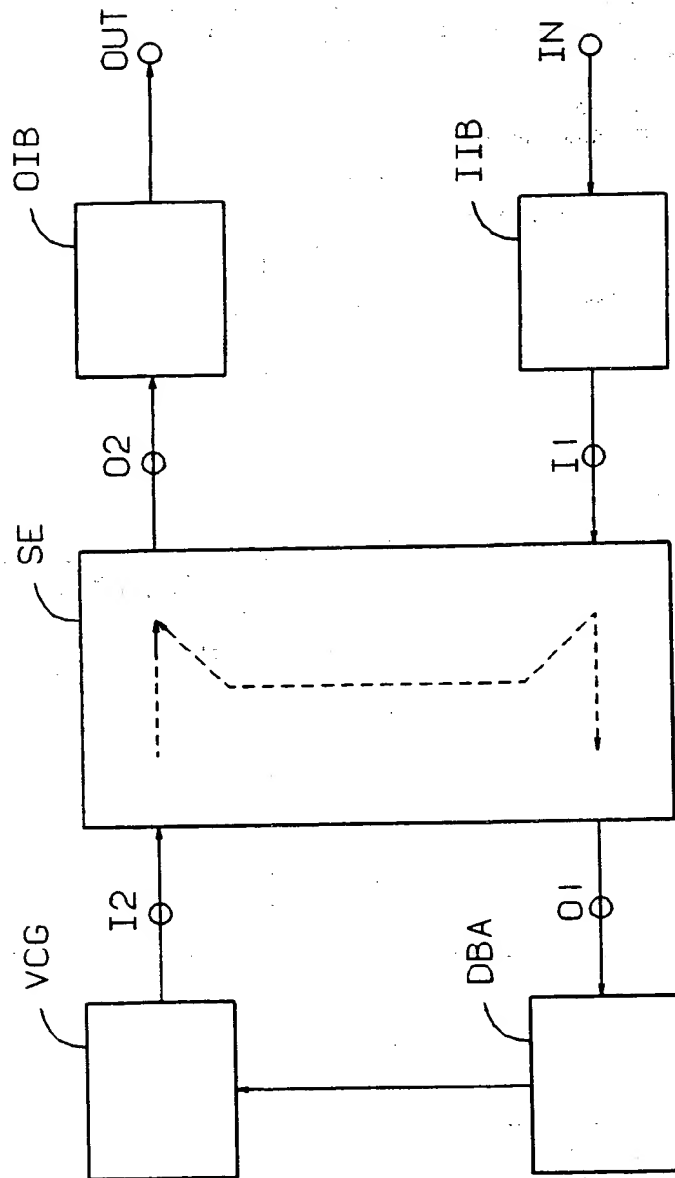
The test packet transmitted from the performance measurement device PMDA to the ATM switching network is routed in the latter to the subscriber location B according to the routing information stored in its header. However, instead of being transmitted directly to B, the ATM switching network has been so initialized that all the packets having the location B as destination are first deviated to the performance measurement device PMDB located near to B as indicated above.

The test packets, as well as any other packets having the subscriber location B as destination, are thus applied to the input terminal IN of PMDB and so further to the input I1 of SE via the input interface board IIB. The switching element SE then performs a selection amongst the test packets originated by the life traffic source at the subscriber location A and which are then transferred to the output 01, and the other packets having also the location B as destination and which are immediately transferred to the output 02. The latter packets are then really transmitted to the life traffic receiver at the subscriber location B via the output interface board OIB, the output terminal OUT of PMDB and the ATM switching network. On the contrary, the test packets are transferred to the distribution based analyzer DBA which, additionally to its above function of distinguishing life packets from idle packets, is also able to recognize test packets and to analyze the contents of their data field, i.e. the performance measurement data, for providing results of the requested performance measurement.

While the principles of the invention have been described above in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

## Claims

1. Performance measurement device (PMD) for at least one communication path between a first and a second subscriber location of a telecommunication packet switching network, said device including test packet generation means (VCG) for generating test packets and for transmitting them through said switching network via said communication path, and packet analyzer means (DBA) for receiving said test packets from said switching network and for measuring the performance characteristics of said communication path, characterized in that said test packet generation means (VCG) are adapted to receive life data communication packets from a life traffic source located at said first subscriber location and to transform said life packets into said test packets.
2. Performance measurement device according to claim 1, characterized in that said test packet generation means (VCG), said packet analyzer means (DBA) and said life traffic source are all connected to said switching network.
3. Performance measurement device according to claim 2, characterized in that said life packets are received in said test packet generation means (VCG) from said life traffic source via said switching network.
4. Performance measurement device according to claim 2, characterized in that it further includes packet switching means (SE) coupled between said life traffic source and said test packet generation means (VCG), said packet switching means being adapted to receive packets and to transmit them either to said test packet generation means (VCG) or to said switching network according to predetermined parameters stored in said packets.
5. Performance measurement device according to claim 2, characterized in that said packet analyzer means (DBA) are coupled between said life traffic source and said test packet generation means (VCG) and are adapted to receive packets, to recognize test packets from life packets and to transmit the latter to said test packet generation means (VCG).
6. Performance measurement device according to claim 5, characterized in that said test packet generation means (VCG) provide one test packet for each of said life packets received from said packet analyzer means (DBA).
7. Performance measurement device according to claim 1, characterized in that each of said packets has a data field and a header which stores routing information indicative of the destination of said packet through said switching network.
8. Performance measurement device according to the claims 6 and 7, characterized in that the data field of said test packet provided by said test packet generation means (VCG) stores performance measurement data.
9. Performance measurement device according to the claims 6 and 7, characterized in that the header of said test packet provided by said test packet generation means (VCG) is at least partly identical to the header of the corresponding life packet received from said packet analyzer means (DBA).
10. Performance measurement device according to the claims 4 and 7, characterized in that said predetermined parameters are stored in the header of said packet.
11. Performance measurement device according to the claims 4 and 9, characterized in that said packet analyzer means (DBA) are coupled between said packet switching means (SE) and said test packet generation means (VCG), and are adapted to measure said performance characteristics in function of performance measurement data stored in the data field of said received test packets.
12. Performance measurement device according to any of the previous claims, characterized in that said switching network is an Asynchronous Transfer Mode (ATM) switching network.
13. Method for measuring the performance characteristics of at least one communication path of a telecommunication packet switching network by transmitting test packets through said network, characterized in that said test packets are life data communication packets of life traffic and of which the communication data is replaced by performance measurement data.



PMD



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## EUROPEAN SEARCH REPORT

Application Number

EP 91 20 2107

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL.5)
Y	IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS vol. 3, May 1984, AMSTERDAM, NL pages 1366 - 1370; W. BOGHADY ET AL.: 'A TECHNIQUE FOR FAULT-DETECTION AND PERFORMANCE MEASUREMENT IN DATA COMMUNICATIONS NETWORKS' * abstract * * page 1366, right column, line 9 - line 30 *	1,2,7,13	H04L12/26
A	---	3-6,8-11	
Y	EP-A-0 427 066 (NATIONAL SEMICONDUCTOR CORPORATION) * abstract * * page 2, line 1 - line 4 *	1,2,7,13	
			TECHNICAL FIELDS SEARCHED (Int. CL.5)
			H04L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 APRIL 1992	Examiner PEREZ PEREZ J. C.
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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